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Unbiased estimation of surface area of single gold nanostars

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Chemical and physical properties of anisotropic metal nanoparticle (NP) are strongly dependent on geometrical factors such as shape and volume [1,2]. Knowledge of such factors is required to adjust the desired properties, e.g. in catalytic and biological applications. Especially the surface area is important: since reactions take place on the surface, the surface area is a major parameter for the assessment of the activity of particles. The 3D complex morphology of anisotropic NP adds to the difficulty to evaluate these parameters as well as the resolution limit of typical characterization techniques.

Transmission electron microscopy delivers a direct and open view of any object, as long as it is small enough (usually < 100nm). The output of its add-on technique, electron tomography, is a digital three-dimensional (3D) dataset that can be sliced at random angles *in silico*. Such slices are known as independent uniform random (IUR) slices, which can be directly used by a set of geometrical tests for the estimation of morphometric parameters of 3D objects based on measurements made on 2D sections (stereology) [3]. Such stereological analysis of Au nanostars [4,5] yielded local characteristics for each randomly chosen particle. Besides volume and surface area [6], other local factors such as curvature [7] could are easily estimated. The basic geometrical estimates related well to data obtained by thresholding and rendering. However, thresholding methods took longer, required smoothing algorithms and where biased due missing edge noise effects. The determination of the surface area by means of electron tomography followed by stereological estimation provides a basis to establish a relationship between surface factors (surface area, curvature, pointyness, ...) and their optical and chemical properties of gold nanostars.

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